

- 1 SEM image
- 2 Optical microscope image

MECHANICALLY INTERCONNECTED CMUT – MICMUT

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General Information

Driven by the desire for higher performance and the opportunity to exploit new applications, the Fraunhofer IPMS is developing a new CMUT concept with mechanically coupled actuators and the following key sensor features:

- Center frequencies in the range 300 kHz to 3 MHz
- Control voltages in the range 30 V to 100 V
- Enhanced sound pressure
- Increased receive sensitivity
- Increased freedom of design
- CMOS compatible and RoHS conformity
- Air-coupled or immersion operation

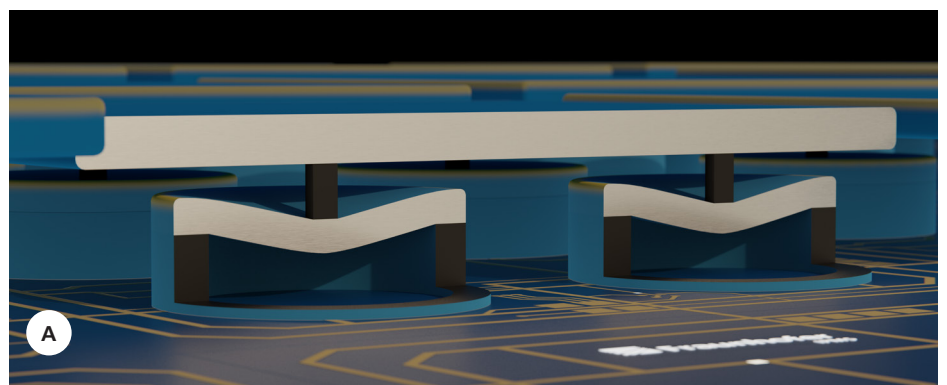


Fig. A Basic actuator configurations

Part of

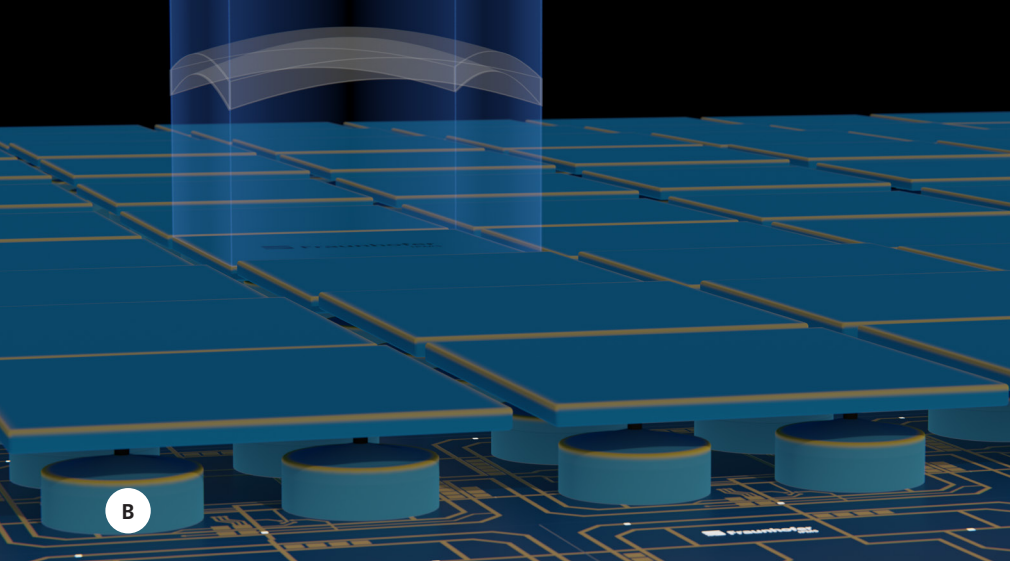


Fig. B Array configurations

Functionality

Conventional capacitive micromachined ultrasonic transducers (CMUTs) are oscillating plates which are excited by an electrostatic field. This class of transducers benefits from the advantages of MEMS technology. In particular, these electrostatic devices exhibit high sensitivity and can be fabricated with high reproducibility in high quantities (batch fabrication). Compact sensor systems with small dimensions are possible which give access to new features and applications. Promoted by microtechnology, ultrasound arrays (Fig. B) can be fabricated cost efficiently.

Currently no MEMS ultrasound transducers are commercially available in a frequency range of 300 kHz up to 3 MHz, which exhibit the described advantages. Therefore, a novel CMUT concept is being developed at the Fraunhofer IPMS.

The sound wave transmitting surface is separated from the electrostatic transducer to improve the electro-mechano-acoustic transduction and permit freedom in geometrical design, combined with the advantages of MEMS technology.

The design freedom gained enables the customization of devices for specific application requirements, such as specific frequency characteristics, excitation signals and acoustic radiation characteristics. The improved fill factor, related to the large movable roof area, contributes to an increased transmitted sound pressure at moderate voltages and low receive power consumption. A further benefit of the CMOS compatible process is the integration of transmit and receive electronics onto a single chip.

The Fraunhofer IPMS experimentally verified the reduction of center frequencies and an increase of fractional bandwidth in air. (Tab. 1)

We offer research, development and pilot-fabrication services in the field of micro-machined ultrasonic transducers (MUT) for both air-coupled and immersion operation.

Applications

The novel device can greatly improve the performance of present ultrasound sensor systems and enable new application fields, addressing gaseous and immersion environments (Fig. C).

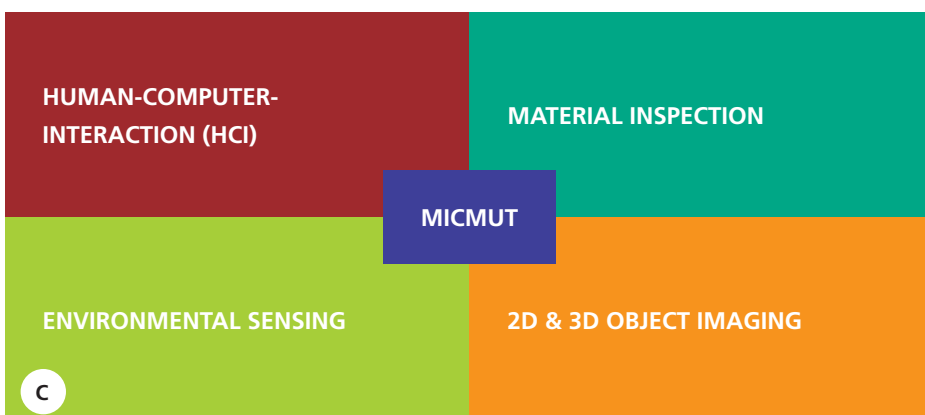


Fig. C Fields of application

Tab. 1 Key parameters of MICMUT

| Parameter | Value |
|-------------------------|---------------------------|
| Center frequency in air | 300 kHz – 3 MHz |
| Bandwidth in air | 5 - 15% |
| Chip size (typ.) | 1.2 x 1.5 mm ² |
| Chip size (min.) | 0.7 x 0.7 mm ² |